CLAIMS

We claim:

1. A method of producing a parametric ultrasonic wave to be decoupled in air to create a decoupled audio wave that closely corresponds to an audio input signal, the method comprising:

(a) ascertaining a linear response over a predefined frequency range of an acoustic output of an electro-acoustical emitter to be used for parametric ultrasonic output; and

(b) creating a parametric ultrasonic processed signal by adjusting linear parameters of at least one sideband frequency range of a parametric ultrasonic signal to compensate for the linear response of the acoustic output of the electro-acoustical emitter such that when the parametric ultrasonic processed signal is emitted from the electro-acoustical emitter, the parametric ultrasonic wave is propagated, having sidebands that are more closely matched at least at a predefined point in space over the at least one sideband frequency range.

2. The method according to claim 1, wherein the linear response of the acoustic output is a function of physical characteristics of the electro-acoustical emitter and an environmental medium wherein the parametric ultrasonic wave is propagated.

3. The method according to claim 1, wherein the linear parameters are selected from the group consisting of amplitude, directivity, time delay, and phase.

4. The method according to claim 1, further comprising the step of adjusting sidebands of the parametric ultrasonic signal to generate an effect that at the predefined point in space, the linear response of the acoustic output of the electro-acoustical emitter is more flat over at least a portion of the predefined frequency range, such that the parametric ultrasonic wave at the predefined point in space closely corresponds to the parametric ultrasonic signal.

5. The method according to claim 1, comprising the more specific step of adjusting the linear parameters of the at least one sideband frequency range corresponding to less than a 3 kHz audio bandwidth.

6. The method according to claim 1, comprising the more specific step of adjusting the linear parameters of the at least one sideband frequency range corresponding to greater than or equal to a 3 kHz audio bandwidth.

7. The method according to claim 1, comprising the more specific step of adjusting the linear parameters of the at least one sideband frequency range to produce sidebands that are closely matched on a linear frequency scale as opposed to a logarithmic frequency scale.

8. The method according to claim 1, wherein the electro-acoustical emitter includes an electrically sensitive and mechanically responsive (ESMR) film emitter.

9. The method according to claim 1, further comprising the step of positioning the predefined point in space near the location of at least one listener.

10. The method according to claim 1, further comprising the step of positioning the predefined point in space near an acoustically reflective surface.

11. The method according to claim 1, further comprising the step of positioning the predefined point in space near an emission surface of the electro-acoustical emitter.

12. The method according to claim 1, further comprising the step of pre-equalizing amplitudes of the parametric ultrasonic signal to compensate for a naturally occurring 12 dB/octave attenuation in amplitudes of frequencies on each side of the carrier signal frequency.

13. A method of producing a parametric ultrasonic wave to be decoupled in air to create a decoupled audio wave that closely corresponds to an audio input signal, the method comprising:

(a) providing an electro-acoustical emitter to be used for parametric ultrasonic wave output, wherein a linear response for an acoustic output from the electro-acoustical emitter is known over a predefined frequency range ;

(b) providing the audio input signal and an ultrasonic carrier signal;

(c) parametrically modulating the audio input signal with the ultrasonic carrier signal, wherein a parametric ultrasonic signal results, comprising:

(i) the ultrasonic carrier wave;

(ii) an upper sideband; and

(iii) a lower sideband;

(d) creating a parametric ultrasonic processed signal by adjusting linear parameters of at least one frequency range of the upper and/or lower sideband of the parametric ultrasonic signal to compensate for the linear response of the acoustic output from the electro-acoustical emitter; and

(e) emitting the parametric ultrasonic processed signal using the electro-acoustical emitter, resulting in the parametric ultrasonic wave having sidebands that are closely matched at least at a predefined point in space over the at least one sideband frequency range.

14. The method according to claim 13, wherein the linear response of the acoustic output is a function of physical characteristics of the electro-acoustical emitter and an environmental medium wherein the parametric ultrasonic wave is propagated.

15. The method according to claim 13, wherein the linear parameters are selected from the group consisting of amplitude, directivity, time delay, and phase.

16. The method according to claim 13, further comprising the step of adjusting the upper and/or lower sidebands of the parametric ultrasonic signal to generate an effect that at the predefined point in space, the linear response of the acoustic output of the electro-acoustical emitter is more flat, such that the parametric ultrasonic wave at the predefined point in space closely corresponds to the parametric ultrasonic signal.

17. The method according to claim 13, comprising the more specific step of adjusting the linear parameters of the at least one frequency range of the upper and/or lower sideband corresponding to less than a 3 kHz audio bandwidth.

18. The method according to claim 13, comprising the more specific step of adjusting the linear parameters of the at least one frequency range of the upper and/or lower sideband corresponding to greater than or equal to a 3 kHz audio bandwidth.

19. The method according to claim 13, comprising the more specific step of adjusting the linear parameters of the at least one frequency range of the upper and/or lower sideband to produce sidebands that are closely matched on a linear frequency scale as opposed to a logarithmic frequency scale.

20. The method according to claim 13, comprising the more specific step of providing an electro-acoustical emitter comprised of an electrically sensitive and mechanically responsive (ESMR) film emitter.

21. The method according to claim 13, further comprising the step of pre-equalizing amplitudes of the parametric ultrasonic signal to compensate for a naturally occurring 12 dB/octave attenuation in amplitudes of frequencies on each side of the carrier signal frequency.

22. A method of producing a parametric ultrasonic wave to be decoupled in air to create a decoupled audio wave that closely corresponds to an audio input signal, the method comprising:

(a) ascertaining a linear response over a predefined frequency range of an acoustic output of an electro-acoustical emitter to be used for parametric ultrasonic output;

(b) setting a target acoustic modulation index for the parametric ultrasonic wave to a predetermined value;

(c) generating a parametric ultrasonic signal having an electrical modulation index that has been set at a higher level than the target acoustic modulation index to compensate for effects of the linear response of the electro-acoustical emitter; and

(d) emitting the parametric ultrasonic signal from the electro-acoustical emitter, resulting in the parametric ultrasonic wave being propagated having the target acoustic modulation index at least at a predefined point in space.

23. The method according to claim 22, comprising the more specific step of generating the parametric ultrasonic signal having an electrical modulation index greater than one, wherein the target acoustic modulation index is less than one.

24. The method according to claim 22, comprising the more specific step of generating a parametric ultrasonic signal having a single sideband.

25. The method according to claim 22, comprising the more specific step of generating a parametric ultrasonic signal having double sidebands.

26. The method according to claim 22, wherein the linear response of the acoustic output is a function of physical characteristics of the electro-acoustical emitter and an environmental medium wherein the parametric ultrasonic wave is propagated.

27. The method according to claim 22, wherein the step of generating a parametric ultrasonic signal having an electrical modulation index that has been set at a higher level than the target acoustic modulation index includes (i) creating a parametric ultrasonic signal by modulating a carrier signal with an audio input signal and (ii) adjusting the electrical modulation index of the parametric ultrasonic signal.

28. The method according to claim 27, wherein the step of adjusting the electrical modulation index includes decreasing the amplitude of a carrier wave.

29. The method according to claim 27, wherein the step of adjusting the electrical modulation index includes adjusting the linear parameters of at least one sideband of the parametric ultrasonic signal.

30. The method according to claim 22, wherein the linear parameters are selected from the group consisting of amplitude, directivity, time delay, and phase.

31. The method according to claim 22, wherein the electro-acoustical emitter includes an electrically sensitive and mechanically responsive (ESMR) film emitter.

32. A method of producing a parametric ultrasonic wave to be decoupled in air to create a decoupled audio wave that closely corresponds to an audio input signal, the method comprising:

(a) providing an electro-acoustical emitter to be used for parametric output, wherein a linear response of an acoustic output from the electro-acoustical emitter is known over a predefined frequency range;

(b) providing the audio input signal and an ultrasonic carrier signal;

(c) parametrically modulating the audio input signal with the ultrasonic carrier signal, wherein a parametric ultrasonic signal results, comprising:

(i) the ultrasonic carrier wave;

(ii) an upper sideband; and

(iii) a lower sideband;

(d) creating a parametric ultrasonic processed signal by adjusting linear parameters of the parametric ultrasonic signal to compensate for effects of the linear response of the acoustic output from the electro-acoustical emitter; and

(e) emitting the parametric ultrasonic processed signal using the electro-acoustical emitter, resulting in the parametric ultrasonic wave having a modulation index that closely approximates a modulation index of the electrical parametric signal at least at a predefined point in space over at least one sideband frequency range.

33. The method according to claim 32, wherein the linear response of the acoustic output is a function of physical characteristics of the electro-acoustical emitter and an environmental medium wherein the parametric ultrasonic wave is propagated.

34. The method according to claim 32, comprising the more specific step of adjusting the linear parameters of the first and/or second sideband so that the modulation index of the parametric ultrasonic wave is optimized at the predefined point in space.

35. The method according to claim 32, comprising the more specific step of adjusting the linear parameters of the carrier wave so that the modulation index of the parametric ultrasonic wave is optimized at the predefined point in space.

36. The method according to claim 32 wherein the linear parameters are selected from the group consisting of amplitude, directivity, time delay, and phase.

37. The method according to claim 32, comprising the more specific step of providing an electro-acoustical emitter comprised of an electrically sensitive and mechanically responsive (ESMR) film emitter.

38. A system for producing a parametric ultrasonic wave to be decoupled in air to create a decoupled audio wave that closely corresponds to an audio input signal, the system comprising:

(a) an electro-acoustical emitter to be used for parametric output, wherein a linear response of an acoustic output from the electro-acoustical emitter is known over a predefined frequency range;

(b) a parametric ultrasonic signal processor coupled to the electro-acoustical emitter, wherein the parametric ultrasonic signal processor is configured to adjust linear parameters of at least one sideband frequency range of the parametric ultrasonic signal to compensate for the linear response of the acoustic output from the electro-acoustical emitter such that when the parametric ultrasonic wave is emitted from the electro-acoustical emitter, the parametric ultrasonic wave is propagated, having sidebands that are closely matched at least at a predefined point in space over the at least one sideband frequency range;

(c) a parametric modulator coupled to the parametric ultrasonic signal processor, for parametrically modulating an ultrasonic carrier signal with the audio input signal to produce the parametric ultrasonic signal; and

(d) ultrasonic carrier and audio input signal sources coupled to the parametric modulator for providing the ultrasonic carrier signal and the audio input signal.

39. The system of claim 38, wherein the parametric ultrasonic signal processor is configured to further modify the linear parameters of the parametric ultrasonic signal to

compensate for the linear response of the acoustic output from the electro-acoustical emitter such that when the parametric ultrasonic processed signal is emitted from the electro-acoustical emitter, the parametric ultrasonic wave is propagated, having a modulation index that is optimized at the predefined point in space over at least a portion of the predefined frequency range.

40. The system of claim 38, wherein the parametric ultrasonic signal processor and the parametric modulator are combined into one device, configured to perform parametric modulation and to adjust the linear parameters of the parametric ultrasonic signal.

41. The system of claim 38, wherein the electro-acoustical emitter includes an electrically sensitive and mechanically responsive (ESMR) film emitter.

42. A method of producing a parametric ultrasonic wave to be decoupled in air to create a decoupled audio wave that closely corresponds to an audio input signal, the method comprising:

(a) ascertaining a linear response over a predefined frequency range of an acoustic output of an electro-acoustical emitter to be used for parametric ultrasonic output; and

(b) creating a parametric ultrasonic processed signal by adjusting linear parameters of a parametric ultrasonic signal to compensate for the linear response of the acoustic output of the electro-acoustical emitter such that when the parametric ultrasonic processed signal is emitted from the electro-acoustical emitter, the parametric ultrasonic wave is propagated as if the linear response of the acoustic output of the electro-acoustical emitter were substantially flat over the predefined frequency range.